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Tech Brief

Computer Modeling and Simulation of NJ Transit Penn Station Newark

FHWA-NJ-2004-016

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SUMMARY:

The project "Computer Modeling and Simulation of New Jersey Transit Penn Station Newark Study" was completed by the NJIT National Center for Transportation and Industrial Productivity staff under contract to the New Jersey Department of Transportation (NJDOT) and under advisement from NJ TRANSIT staff. The purpose of the project was to model the impacts of proposed traffic improvements to the Newark's Penn Station pick-up/drop-off facilities and to the surrounding roadway infrastructure.

As part of the project, a Paramics simulation model for the study area surrounding the Newark Penn Station was built and calibrated to existing conditions. Analyses were conducted for the base 'No Build' condition, as well as for the planned NJDOT / City of Newark improvements and for multiple NJ TRANSIT recommendations. Analyses were also completed to determine the impact of large future developments in the immediate vicinity of Newark Penn Station.

The major findings of the report include:

- The NJDOT/City of Newark proposal of adding a left turn from Raymond Boulevard Westbound (WB) to Route 21 (McCarter Highway) Southbound (SB) results in negative impact and increased delay for all vehicle trips on Raymond Boulevard and buses on Market Street.
- NJ Transit's combined recommendations (as outlined in the section below) result in significant improvements and a reduction in delay for all vehicles and person trips on both Raymond Boulevard and on Market Street.
- The most effective way to improve bus, auto, and truck circulation in the vicinity of Newark Penn Station is to implement NJ TRANSIT's recommendations and remove the proposed NJDOT/City of Newark allowance of left turn vehicles from Raymond Boulevard to Route 21 SB from further consideration.

INTRODUCTION/BACKGROUND:

For security reasons New Jersey Transit (NJ TRANSIT) temporarily blocked non-authorized vehicle access to Raymond Plaza East in downtown Newark. The closing was intended to help bus transit movements serving the Penn Station Newark and increase security around this important transportation hub. The local roadways are very congested during evening peak hours and NJ TRANSIT bus movements in and out of the bus depot under the Northeast Corridor rail line were difficult to complete and buses were experiencing large delays. In conjunction with NJDOT improvements to NJ Route 21 (McCarter Highway) in downtown Newark, NJ TRANSIT saw the opportunity to make improvements to the roadway system and improve bus flows around Newark Penn Station.

RESEARCH APPROACH:

To properly conduct analyses of this tightly spaced roadway network with heavy congestion during the evening peak hours, NJ TRANSIT required a simulation model to be developed of the traffic conditions and network in the study area around Newark Penn Station. The model development was primarily motivated by the following needs:

- (1) A visual and analytical platform to test the different short-term solutions, including optimized traffic signals and bus lanes.
- (2) A 3D model that can be used to show what improvements to Newark Penn Station are planned for the area, and how the system will operate in the future.

The NJIT team coordinated with NJ TRANSIT to define the study area for the model. This area was defined as the area within a circle of radius 1,500 ft having its origin and center point at Newark Penn Station.

In order to calibrate the simulation models, data had to be gathered. The data captured comprised of information such as:

- Detailed road geometry (e.g. number of lanes, width of lanes, posted speed limits, etc.),
- Parking behavior and restrictions,
- Hourly traffic turning movement counts,
- Traffic signal location, signal plans, cycles, and timing,
- Queue information at intersection approaches, and

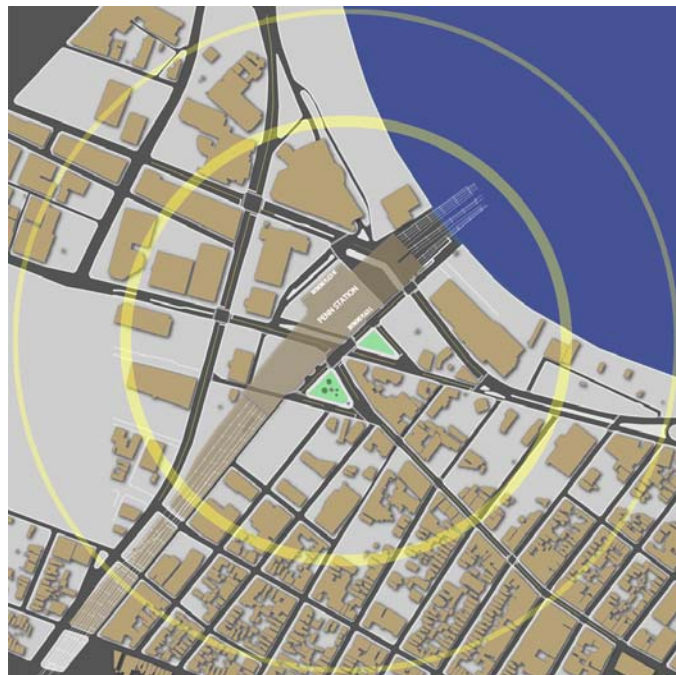


Illustration Map of the Newark Penn Station Project Study Area

- Bus operation parameters (e.g. headways, average travel speeds, recovery time, etc.).

This data was collected from NJ TRANSIT, its consultants, NJDOT, and City of Newark. Where information was not readily available, efforts were made to collect data through site visits. Information gathered during these site visits comprised of the collection of queue information, any missing traffic counts that were not readily available, and an inventory of the traffic behavior in the study area.

The procedure for developing the traffic simulation model was done in three steps; development of model, calibration, and validation. A critical step in the development of the model was the estimation of an origin-destination (OD) matrix that defines the vehicular demand for the network. The estimation of how many vehicles were traveling from one portion of the network to another was completed through linear programming based on turning counts collected under previous work efforts by NJ TRANSIT and their consultants and on probabilistic demand routes through the study area.

Using the model developed, the NJIT team created evening peak hour simulation models for the each of the following scenarios:

- No Build (Post Route 21 Improvements)
- NJDOT / City of Newark Recommendation: Allow left turns from Raymond Blvd WB to Route 21 SB and construction of a turning bay.
- NJ TRANSIT Recommendation #1: Construct a Bus Priority Lane on Raymond Blvd WB from Raymond Plaza East to Route 21. Various placements of the lane and signal treatments were considered.
- NJ TRANSIT Recommendation #2: Reconstruct Raymond Plaza West (RPW) to two-way flows to replace the existing one-way pick-up / drop-off location with a more flexible two-way flow with a rotary system for maximum user flexibility.
- NJ TRANSIT Recommendation #3: Reconstruct Raymond Plaza East (RPE) between Market Street and Commerce Street to create a secondary pick-up / drop-off location for Penn Station users.
- NJ TRANSIT Combined Recommendations #1, #2, and #3: Implement the best scenarios developed for all NJ TRANSIT recommendations.
- Future Development Impacts

The results of the various scenarios simulation runs were compared against the existing model and the results summarized.

The findings of the study were reported to the NJ TRANSIT project management team and later to NJ TRANSIT executives. From these meetings, the structure and content of the final presentation was determined, and a finished presentation of the key findings was prepared. That presentation was delivered to NJ TRANSIT executives, the City of Newark, NJDOT, and other key stakeholders on December 4, 2003.

FINDINGS:

The study reported the following findings from the evening peak hour simulation analysis:

- The NJDOT / City of Newark proposal results in negative impact and increased delay for all vehicles and trips on Raymond Blvd and for autos and trucks on Market Street.
- NJ TRANSIT's combined recommendations result in significant improvement and reduction in delay for all vehicles and trips on both Raymond Blvd and on Market Street.
- Implementing a bus priority lane on Raymond Blvd WB in the left-most lane with signal pre-emption and signalization, reduces bus delay by over 60% on Raymond Blvd and increases delay for autos and trucks by 20%. Changes on Market Street are negligible for all vehicles.
- Implementing only the WB Leftmost Bus Priority Lane on Raymond Blvd, with no bus signal preference, reduces bus delay close to 40% on Raymond Blvd, while having no impact on auto or truck traffic. A nominal increase in delay for all vehicles is experienced on Market Street.
- Implementing only RPW two-way flow worsens conditions for buses on both Raymond Blvd and on Market Street during evening peak hour conditions.
- Implementing all three NJ TRANSIT recommendations results in the most significant benefit for all vehicles and trips on both Raymond Blvd and on Market Street.
 - On Raymond Blvd, delay for buses is reduced over 60% and for all trips by 40%. Auto and truck delay is reduced over 20%.
 - On Market Street, bus and all trips delays are reduced by about 20%, while autos and trucks would experience over a 55% reduction in delay.
- The most effective way to improve bus, auto and truck circulation in the vicinity of Newark Penn Station is to implement NJ TRANSIT's recommendations and remove the NJDOT / City of Newark proposed left turn lane from further consideration.

CONCLUSIONS AND RECOMMENDATIONS:

In consultation with NJ TRANSIT and the City of Newark, it was concluded that the improvements be introduced in phases. The phases were determined by examining the benefits to be gained versus the anticipated costs (as developed by NJ TRANSIT). The phases proposed are as follows:

- Phase 1: Continue left turn prohibition from Raymond Boulevard WB to Route 21 SB.
- Phase 2: Add Left-most bus priority lane on Raymond Boulevard WB from Raymond Plaza East to Route 21 without signal pre-emption or synchronization.
- Phase 3: Implement additional pick-up/drop-off on Raymond Plaza East at Market Street and Commerce Street.
- Phase 4: Reconstruct Raymond Plaza West two-way flow with rotary; add bus signal phasing (queue jump) on Raymond Boulevard WB at Route 21 and signal synchronization on Raymond Boulevard from Raymond Plaza East through Route 21.

A key conclusion from this project is that if future development and redevelopment is to be viable in the downtown Newark area surrounding Penn Station, increasing transit

mode share is critical. Analyses reveal that the existing roadway infrastructure (with the above proposed improvements) cannot accommodate the traffic generated by additional buildings proposed to be built in the downtown core. To maintain circulation levels comparable to those that will result from the widening of Route 21, the transit mode share must increase from 35% to at least 50%.

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<p>A final report is available online at http://www.state.nj.us/transportation/research/research.html</p> <p>If you would like a copy of the full report, please FAX the NJDOT, Division of Research and Technology, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Division@dot.state.nj.us and ask for:</p> <p>Computer Modeling and Simulation of NJ Transit Penn Station Newark</p> <p>NJDOT Research Report No: FHWA-NJ-2004-016</p>	